



3-28-16

**US EPA
Source Test Report**

**XTO Energy, Inc.
Little Canyon Compressor Station Facility
Utah**

March 9, 2016

Permit: N/A

**Engine: Caterpillar G3516LE
SN: 4EK03003
Unit ID: LCU #4**

Prepared By:

Oasis Emission Consultants, Inc.
2730 Commercial Way
Rock Springs, WY 82901





March 28, 2016

Mr. Craig Allison
XTO Energy, Inc.
810 Houston Street
Fort Worth, Texas 76102

Dear Mr. Allison:

Re: Engine Emission Testing For XTO Energy, Inc., Little Canyon Compressor Station Facility, Unit LCU #4, Permit N/A.

Oasis Emission Consultants, Inc. was requested to perform an annual engine emission test on a Caterpillar G3516LE lean burn engine (Permit N/A) located in Utah.

Emission Levels

The average recorded levels are shown in the attached report and summarized below.

Emission Unit	Avg NOx	Avg CO
g/bhp-hr	1.66	0.00
lbs/hr	4.20	0.01

Formaldehyde Levels

Test Run	HCOH ppmvd	HCOH ppmvd @ 15% O2	HCOH ppmvd @ 15% O2 Limit
1	5.01	2.40	14
2	5.08	2.45	14
3	4.98	2.43	14
AVG	5.02	2.43	14

Catalyst Parameters

Test Run	Inlet Temp (deg F)	DP (in H ₂ O)
1	820	2.4
2	815	2.4
3	813	2.4
AVG	816	2.4

Engine Load

Test Run	BHP	% Load
1	1132.7	84.5
2	1152.1	86.0
3	1181.4	88.2
AVG	1155.4	86.2

Testing Protocol

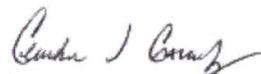
The attached report was generated using an extractive FTIR system using methodologies as required by EPA 40 CFR 60(A) Methods 1 and 19 & EPA 40 CFR 63(A), Method 320 and/or ASTM D 6348-03, as well as ASTM D6522-00(2005).

Quality Assurance

Oasis has performed a full cursory review of the raw data and calculated results in this report. Any errors we have encountered have been listed in the body of this report. After performing the review, we are confident that this engine has met all requirements.

If you have any questions or require further information, please contact the undersigned at (307) 382-3297.

Yours truly,
Oasis Emission Consultants, Inc.



Cember Crawley
Environmental Scientist



Charles A. Chapman
Senior Environmental Scientist



Christopher N. Knott, P.Eng.
Director, Engineering & Operations

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SOURCE EMISSION TEST REPORT

PERMIT N/A

Test Performed By: **Oasis Emission Consultants, Inc.**

Facility Name: **Little Canyon Compressor Station**
Facility Unit LCU #4

Emission Source: **Caterpillar G3516LE**

Date of Test: **March 9, 2016**

Date of Report: **March 28, 2016**

1.1 Introduction

The purpose of this source test was to demonstrate that source emissions from a Caterpillar G3516LE engine were below maximum allowable levels specified by EPA 40 CFR 63, Subpart ZZZZ.

The Caterpillar G3516LE engine is a lean burn engine that employs an Oxidation Catalytic Converter to regulate emission levels.

Three test runs were performed on March 9, 2016 to analyze NOx, CO & HCOH emission levels. Test runs were performed according to methodologies outlined by EPA 40 CFR 60(A) Methods 1 and 19, and in the ASTM D 6348-03 & EPA 40 CFR 63(A), Method 320 Protocol. Effluent exhaust was sampled from the engine through an extractive heated stainless steel sample line interconnected to an MKS 2030 FTIR analyzer.

Each of the three runs consisted of sixty (60) readings taken at one (1) minute intervals.

Test runs were observed by the following individuals:

- Kevin Watkins, OEC
- Derrick, XTO

2.1 Equipment Utilization

The following equipment was used during the tests performed at this facility in conjunction with procedures outlined by EPA 40 CFR 60(A) Methods 1 and 19 & EPA 40 CFR 63(A), Method 320 and/or ASTM D 6348-03, as well as ASTM D6522-00(2005).

- (1) MKS MultiGas 2030 FTIR Continuous Gas Analyzer
- (1) Laptop Computer for the FTIR Analyzer using MKS MG2000 Software
- (1) 75ft or 100ft Heated Teflon Line w/ Heated Sample Probe & Spike Bypass Line
- (1) Portable O₂/CO₂ Analyzer
- (6) EPA Protocol G1 Calibration Gas (NO_x, CO, C₃H₈, CH₃CHO, C₂H₄ & NO₂)

The MKS Multigas 2030 FTIR Analyzer was used to measure NO_x & CO on a dry basis. Formaldehyde levels were measured on a wet basis and were corrected to produce levels on a dry basis. A pre Direct and System calibration measurement was made on compounds of NO_x, CO, CH₃CHO, C₃H₈ & C₂H₄. In addition, a post Direct calibration was made on compounds of NO_x, CO, CH₃CHO, C₃H₈ & C₂H₄. Compounds of CO₂, CO, NO, CH₃CHO & C₃H₈ were measured for the quality assurance spiking requirements of EPA 40 CFR 63(A), Method 320 & ASTM D 6348-03.

When a gas sample is introduced in the gas cell, the infrared beam is partially absorbed by the gas species present. The spectral frequencies absorbed and their intensity are due to the atoms associated with the chemical bond and the strength of that bond. The absorption spectrum is unique for each infrared-active gas. The MKS Analyzer measures the absorption spectrum, and its analysis algorithm measures the concentration of each gas using pre-loaded calibrations. The MG2000 software allows for the continuous measurement, display and recording of the sample stream.

The MKS Multigas 2030 FTIR Analyzer operated with a spectral resolution of 0.5 cm⁻¹ and a scan time of 30 seconds. The FTIR spectrometer utilizes a multi-pass gas cell with a 5.11 meter effective pathlength.

3.1 Discussion of NOx, CO & HCOH Test Results

Please refer to Appendix A for the raw NOx, CO & HCOH test results. Please refer to Appendix B for a listing of all raw data, calibration error response and calculations performed per ASTM & EPA requirements. Overall the average emission levels complied with Subpart ZZZZ requirements. Testing for NOx, CO & HCOH were run concurrently with one another.

3.1.1 Source Test 1: Caterpillar G3516LE, NOx, CO & HCOH

The first test was performed from 13:24 to 14:23 for NOx, CO & HCOH.

Based on the approximated load of **1132.7 bhp**, the average NOx and CO levels were found to be **1.95 g/bhp-hr and 0.00 g/bhp-hr** respectively. The HCOH tested at **2.40 ppmvd @ 15% O₂** during this test period.

Test Run	NOx (ppmvd)	NOx (g/bhp-hr)	CO (ppmvd)	CO (g/bhp-hr)	HCOH (ppmvd)	HCOH (ppmvd @ 15% O ₂)
1	260.00	1.95	0.92	0.00	5.01	2.40

3.1.2 Source Test 2: Caterpillar G3516LE, NOx, CO & HCOH

The second test was performed from 14:29 to 15:28 for NOx, CO & HCOH.

Based on the approximated load of **1152.1 bhp**, the average NOx and CO levels were found to be **1.96 g/bhp-hr and 0.00 g/bhp-hr** respectively. The HCOH tested at **2.45 ppmvd @ 15% O₂** during this test period.

Test Run	NOx (ppmvd)	NOx (g/bhp-hr)	CO (ppmvd)	CO (g/bhp-hr)	HCOH (ppmvd)	HCOH (ppmvd @ 15% O ₂)
2	258.31	1.96	0.89	0.00	5.08	2.45

3.1.3 Source Test 3: Caterpillar G3516LE, NOx, CO & HCOH

The third test was performed from 16:34 to 17:33 for NOx, CO & HCOH.

Based on the approximated load of **1181.4 bhp**, the average NOx and CO levels were found to be **1.06 g/bhp-hr and 0.00 g/bhp-hr** respectively. The HCOH tested at **2.43 ppmvd @ 15% O₂** during this test period.

Test Run	NOx (ppmvd)	NOx (g/bhp-hr)	CO (ppmvd)	CO (g/bhp-hr)	HCOH (ppmvd)	HCOH (ppmvd @ 15% O ₂)
3	139.21	1.06	0.74	0.00	4.98	2.43

4.1 Stack Sampling Location

The sampling port for moisture, flow, NOx, CO and HCOH measurements was a minimum of 2.0 pipe diameters from the nearest upstream flow disturbance and 0.5 pipe diameters from the nearest downstream disturbance.

4.2 Stack Sampling Methods & Procedures

Testing followed EPA 40 CFR 60(A) Methods 1 and 19 & EPA 40 CFR 63(A), Method 320 and/or ASTM D 6348-03, as well as ASTM D6522-00(2005) methodologies per our standard protocol, with no exceptions.

5.1 Quality Assurance

CTS procedures were followed according to ASTM requirements for both pre and post testing. Similarly, QA spiking procedures were followed. Analysis of the CO₂ exhaust effluent was used to determine the dilution factor. Steady levels of the CO₂ were observed and a sufficient duration of time was allowed to elapse for a representative average.

The calibration gas was spiked into the effluent stream using a bypass line at approximately 10% of the sampling rate. The dilution factor was obtained from observation of the stack CO₂ behavior using the following equation:

$$DF = \frac{CO_2\text{AVG} - CO_2\text{SPIKE}}{CO_2\text{ AVG}}$$

Where: CO₂AVG = The average undiluted CO₂ stack gas concentration of spike measurements
CO₂SPIKE = The average diluted CO₂ stack gas concentration when spiked

The sample recovery was then obtained from the following equation:

$$\frac{\% \text{ REC} = (Spike \text{ MEAS} - Stack \text{ MEAS}) * (1 - DF)}{CS * DF}$$

Where: Spike MEAS = The average diluted stack gas concentration when spiked
Stack MEAS = The average undiluted stack gas concentration
DF = Dilution factor
CS = Certified concentration of calibration standards

The Sample Recovery average level for CO, NO, C₃H₈ & CH₃CHO was found to be 113.8%, 116.2%, 113.8% & 78.1% respectively, which was within the allowable tolerance of Method 320 (70% to 130%). A summary of all spiking procedures/results can be found in Appendix B.

APPENDIX A

XTO Energy, Inc.
Little Canyon Compressor Station LCU #4

Record	FTIR Measurements				Date	Time
	NOx Dry (ppm)	CO Dry (ppm)	Formaldehyde 191C Wet (ppm)	H2O% (High) 191C		
1	260.247956	1.06762	4.171251	11.630389	3/9/2016	13:24:12
2	260.432466	0.93258	4.137388	11.810174	3/9/2016	13:25:12
3	256.544587	0.853121	4.105379	11.498033	3/9/2016	13:26:12
4	257.894449	0.936991	4.179814	12.165245	3/9/2016	13:27:12
5	251.376985	0.921928	4.422547	13.174305	3/9/2016	13:28:12
6	261.438572	0.920634	4.348822	12.973904	3/9/2016	13:29:12
7	254.864629	0.962461	4.34169	12.39739	3/9/2016	13:30:12
8	250.967319	1.022134	4.407149	11.959942	3/9/2016	13:31:11
9	257.30306	0.921737	4.4304	12.213025	3/9/2016	13:32:11
10	247.31862	0.915475	4.204286	12.003491	3/9/2016	13:33:11
11	261.116018	0.933421	4.420339	12.679121	3/9/2016	13:34:11
12	255.396292	0.946383	4.370576	12.474089	3/9/2016	13:35:11
13	261.079253	0.963447	4.229301	11.566515	3/9/2016	13:36:11
14	254.993322	0.999166	4.204839	10.993978	3/9/2016	13:37:11
15	252.003318	1.00153	4.79498	12.646133	3/9/2016	13:38:11
16	258.548078	0.983908	4.589878	12.713733	3/9/2016	13:39:10
17	258.986262	0.962699	4.69255	12.669735	3/9/2016	13:40:10
18	252.612546	0.89432	4.360834	12.070326	3/9/2016	13:41:10
19	252.761284	0.961598	4.316969	11.920427	3/9/2016	13:42:10
20	253.688587	1.032434	4.310293	12.303651	3/9/2016	13:43:10
21	265.018005	0.905236	4.429677	12.371399	3/9/2016	13:44:10
22	263.992353	0.887957	4.101302	11.297133	3/9/2016	13:45:10
23	264.256983	0.999926	4.102067	11.730925	3/9/2016	13:46:10
24	261.566851	0.856174	4.826589	13.435001	3/9/2016	13:47:10
25	261.699947	0.946971	4.555832	12.782935	3/9/2016	13:48:09
26	266.324184	0.903413	4.535495	12.493739	3/9/2016	13:49:09
27	264.543791	0.9402	4.350772	12.107095	3/9/2016	13:50:09
28	258.026189	0.872125	4.369579	12.267604	3/9/2016	13:51:09
29	259.651782	1.002068	4.35017	11.98961	3/9/2016	13:52:09
30	259.05576	0.900065	4.337217	11.94134	3/9/2016	13:53:09
31	260.57226	0.990701	4.459877	12.299807	3/9/2016	13:54:09
32	260.112838	0.943443	4.422949	12.268157	3/9/2016	13:55:09
33	260.591268	0.859612	4.40809	12.486688	3/9/2016	13:56:09
34	261.324193	0.861829	4.548598	12.380136	3/9/2016	13:57:08
35	263.832697	0.960169	4.65781	12.11057	3/9/2016	13:58:08
36	262.208153	0.939168	4.440714	11.80285	3/9/2016	13:59:08
37	254.419016	0.950433	4.264976	12.043893	3/9/2016	14:00:08
38	261.585157	0.87948	4.381824	12.583774	3/9/2016	14:01:08
39	263.427461	0.901848	4.506101	12.661871	3/9/2016	14:02:08
40	261.908492	0.878731	4.587817	12.431727	3/9/2016	14:03:08
41	258.220469	0.929649	4.497878	12.000307	3/9/2016	14:04:08
42	265.682534	0.892922	4.265616	12.104541	3/9/2016	14:05:07
43	256.919987	0.91844	4.318173	12.174065	3/9/2016	14:06:07
44	262.443821	0.87891	4.34271	12.593832	3/9/2016	14:07:07
45	265.941523	0.891958	4.384022	12.453835	3/9/2016	14:08:07
46	265.300755	0.832335	4.257439	11.399287	3/9/2016	14:09:07
47	262.336019	0.84337	4.359173	11.639726	3/9/2016	14:10:07
48	262.424186	0.866345	4.239654	12.190034	3/9/2016	14:11:07
49	266.152583	0.799819	4.308	12.742519	3/9/2016	14:12:07
50	266.051742	0.870027	4.340462	12.487551	3/9/2016	14:13:07
51	266.522616	0.880346	4.39307	12.41774	3/9/2016	14:14:07
52	263.675492	0.964027	4.363206	12.09385	3/9/2016	14:15:06
53	257.186549	0.885962	4.51656	11.872035	3/9/2016	14:16:06
54	254.520938	0.953448	4.313067	11.410437	3/9/2016	14:17:06
55	255.02285	0.98172	4.234763	11.288246	3/9/2016	14:18:06
56	269.641442	0.892576	4.320554	11.97861	3/9/2016	14:19:06
57	257.75041	0.858434	4.608121	13.119704	3/9/2016	14:20:06
58	261.344689	0.875643	4.63165	13.196688	3/9/2016	14:21:06
59	261.93557	0.858194	4.667346	12.815104	3/9/2016	14:22:06
60	267.440249	0.844785	4.78685	12.360389	3/9/2016	14:23:05
AVG	260.00	0.92	4.40	12.23		
ppm@15% O2	124.72	0.44				

Calculated Emission Levels							
NOx (g/bhp-hr)	NOx (lbs/hr)	CO (g/bhp-hr)	CO (lbs/hr)	HCOH Dry (ppm)	HCOH@15% O2 (ppm)	HCOH (g/bhp-hr)	HCOH (lbs/hr)
1.95	4.88	0.00	0.01	5.01	2.40	0.025	0.062

XTO Energy, Inc.
Little Canyon Compressor Station LCU #4

Run 2

Record	FTIR Measurements				Date	Time
	NOx Dry (ppm)	CO Dry (ppm)	Formaldehyde 191C Wet (ppm)	H2O% (High) 191C		
1	266.334428	0.878863	4.128888	10.158048	3/9/2016	14:29:26
2	261.900403	0.819043	4.559811	12.778374	3/9/2016	14:30:26
3	258.846551	0.873565	4.470736	12.89427	3/9/2016	14:31:26
4	259.169949	0.925527	4.528233	12.682187	3/9/2016	14:32:26
5	259.478611	0.892613	4.651743	13.041508	3/9/2016	14:33:26
6	254.874601	0.862691	4.568326	13.090212	3/9/2016	14:34:26
7	263.79074	0.891026	4.58024	12.546655	3/9/2016	14:35:26
8	250.926456	0.915808	4.485468	12.175216	3/9/2016	14:36:26
9	255.997549	0.948265	4.302178	11.640522	3/9/2016	14:37:25
10	251.541111	0.946553	4.301074	11.346959	3/9/2016	14:38:25
11	259.136643	0.949921	4.207286	12.064552	3/9/2016	14:39:25
12	257.142851	0.847799	4.415894	12.653181	3/9/2016	14:40:25
13	252.762227	0.830148	4.470319	12.810417	3/9/2016	14:41:25
14	245.634562	0.881513	4.360019	12.054761	3/9/2016	14:42:25
15	243.650525	0.942534	4.319797	11.970466	3/9/2016	14:43:25
16	243.882386	0.88045	4.340385	11.757752	3/9/2016	14:44:24
17	230.187152	1.069253	4.397767	11.400598	3/9/2016	14:45:24
18	241.131016	0.924746	4.761476	12.602914	3/9/2016	14:46:24
19	258.645949	0.940374	4.722114	12.969822	3/9/2016	14:47:24
20	255.405756	0.986648	4.822325	12.587339	3/9/2016	14:48:24
21	257.8299	0.974355	4.45555	12.009694	3/9/2016	14:49:24
22	253.669295	0.872386	4.399983	12.219617	3/9/2016	14:50:24
23	261.331032	0.932114	4.365959	12.092593	3/9/2016	14:51:24
24	261.183542	0.896022	4.176644	11.352337	3/9/2016	14:52:24
25	264.016133	0.985117	4.218354	11.458012	3/9/2016	14:53:23
26	259.359195	0.819495	4.442162	12.666034	3/9/2016	14:54:23
27	264.005834	0.942889	4.44233	12.276622	3/9/2016	14:55:23
28	258.023591	0.821947	4.561931	12.794887	3/9/2016	14:56:23
29	261.369523	0.777163	4.578787	12.871681	3/9/2016	14:57:23
30	254.247646	0.851796	4.477042	11.995213	3/9/2016	14:58:23
31	264.507863	0.866718	4.460345	11.725711	3/9/2016	14:59:23
32	258.52035	0.963979	4.378938	12.164963	3/9/2016	15:00:23
33	256.769724	0.900053	4.412136	12.318911	3/9/2016	15:01:23
34	259.242045	0.925646	4.464558	12.461989	3/9/2016	15:02:22
35	258.802281	0.863712	4.545346	12.294012	3/9/2016	15:03:22
36	261.541735	0.829841	4.458107	12.326669	3/9/2016	15:04:22
37	257.779173	0.826877	4.484186	12.500645	3/9/2016	15:05:22
38	261.820764	0.880143	4.623743	12.574198	3/9/2016	15:06:22
39	263.537501	0.839076	4.429902	12.268927	3/9/2016	15:07:22
40	265.85255	0.943668	4.370532	12.064407	3/9/2016	15:08:22
41	258.068719	0.949159	4.34057	11.557121	3/9/2016	15:09:22
42	255.24623	0.920298	4.263593	11.558287	3/9/2016	15:10:21
43	255.780807	0.895732	4.342258	12.03883	3/9/2016	15:11:21
44	262.077971	0.87149	4.466124	12.178183	3/9/2016	15:12:21
45	265.85023	0.90376	4.410991	12.12144	3/9/2016	15:13:21
46	261.047206	0.930146	4.37804	11.74518	3/9/2016	15:14:21
47	263.039598	0.881888	4.343267	11.902154	3/9/2016	15:15:21
48	269.817785	0.913842	4.361924	12.294506	3/9/2016	15:16:21
49	261.242436	0.821101	4.302365	12.122583	3/9/2016	15:17:21
50	264.893656	0.868052	4.380123	12.3402	3/9/2016	15:18:21
51	257.188928	0.880413	4.470444	12.145941	3/9/2016	15:19:20
52	268.332954	0.933051	4.441868	12.182727	3/9/2016	15:20:20
53	262.221302	0.867222	4.506862	12.294463	3/9/2016	15:21:20
54	262.525347	0.858375	4.542756	12.518679	3/9/2016	15:22:20
55	253.119614	0.837046	4.538031	12.10869	3/9/2016	15:23:20
56	252.502178	0.863755	4.61009	12.042005	3/9/2016	15:24:20
57	263.656291	0.877379	4.67157	12.407716	3/9/2016	15:25:20
58	262.492848	0.870802	4.451752	12.946431	3/9/2016	15:26:20
59	264.641116	0.845627	4.622072	13.038679	3/9/2016	15:27:20
60	260.929124	0.883516	4.661256	13.094048	3/9/2016	15:28:19
AVG	258.31	0.89	4.45	12.24		
ppm@15% O2	124.92	0.43				

Calculated Emission Levels							
NOx (g/bhp-hr)	NOx (lbs/hr)	CO (g/bhp-hr)	CO (lbs/hr)	HCOH Dry (ppm)	HCOH@15% O2 (ppm)	HCOH (g/bhp-hr)	HCOH (lbs/hr)
1.96	4.97	0.00	0.01	5.08	2.45	0.025	0.064

XTO Energy, Inc.
Little Canyon Compressor Station LCU #4

Run 3

Record	FTIR Measurements				Date	Time
	NOx Dry (ppm)	CO Dry (ppm)	Formaldehyde 191C Wet (ppm)	H2O% (High) 191C		
1	130.095111	0.742972	4.17954	11.505794	3/9/2016	16:34:09
2	134.972778	0.761069	4.170359	11.508728	3/9/2016	16:35:09
3	137.272126	0.826265	4.259672	11.836606	3/9/2016	16:36:09
4	140.337068	0.684717	4.35278	12.365704	3/9/2016	16:37:09
5	137.31663	0.769562	4.47194	12.547064	3/9/2016	16:38:09
6	134.967971	0.718781	4.48949	12.560037	3/9/2016	16:39:09
7	136.451765	0.767726	4.625677	12.705884	3/9/2016	16:40:09
8	135.134038	0.766888	4.772099	12.806273	3/9/2016	16:41:09
9	133.836172	0.703498	4.749544	12.636009	3/9/2016	16:42:09
10	140.327905	0.742499	4.387825	12.024994	3/9/2016	16:43:08
11	135.683766	0.758223	4.147282	11.327301	3/9/2016	16:44:08
12	142.126454	0.770916	3.941222	10.994702	3/9/2016	16:45:08
13	137.899958	0.765822	3.963916	10.810567	3/9/2016	16:46:08
14	136.113748	0.635124	3.834194	10.584838	3/9/2016	16:47:08
15	139.763674	0.817504	3.875112	10.679055	3/9/2016	16:48:08
16	138.93307	0.722191	4.219204	11.702258	3/9/2016	16:49:08
17	141.386481	0.6968	4.134416	11.627005	3/9/2016	16:50:08
18	143.170656	0.811907	4.192335	11.80009	3/9/2016	16:51:07
19	145.988514	0.79819	4.345167	12.185408	3/9/2016	16:52:07
20	144.767228	0.722814	4.810245	13.496573	3/9/2016	16:53:07
21	148.964932	0.662325	4.573498	12.489569	3/9/2016	16:54:07
22	142.437789	0.743364	4.739678	12.641818	3/9/2016	16:55:07
23	141.36725	0.76601	4.446502	12.646522	3/9/2016	16:56:07
24	142.385867	0.69138	4.24625	11.937795	3/9/2016	16:57:07
25	143.087023	0.681948	4.240933	11.96613	3/9/2016	16:58:07
26	144.348249	0.74237	4.421167	12.769923	3/9/2016	16:59:07
27	138.620022	0.747284	4.610601	13.029327	3/9/2016	17:00:06
28	140.452008	0.737622	4.67975	12.853503	3/9/2016	17:01:06
29	136.674967	0.726422	4.628079	12.702312	3/9/2016	17:02:06
30	137.237814	0.677772	4.619307	12.489215	3/9/2016	17:03:06
31	135.304467	0.724091	4.539629	12.486022	3/9/2016	17:04:06
32	136.710671	0.830113	4.459563	12.353985	3/9/2016	17:05:06
33	142.384444	0.807738	4.479287	12.307415	3/9/2016	17:06:06
34	134.90405	0.731796	4.349093	12.194002	3/9/2016	17:07:06
35	140.40409	0.719157	4.312778	12.069578	3/9/2016	17:08:06
36	145.818776	0.712206	4.320618	11.887546	3/9/2016	17:09:05
37	142.405002	0.745276	4.21769	11.916061	3/9/2016	17:10:05
38	150.483242	0.834828	4.337855	12.087564	3/9/2016	17:11:05
39	147.871878	0.755858	4.377831	12.129946	3/9/2016	17:12:05
40	150.367375	0.668715	4.337104	12.187564	3/9/2016	17:13:05
41	150.150699	0.702387	4.313108	12.310431	3/9/2016	17:14:05
42	151.269657	0.795232	4.426368	12.388872	3/9/2016	17:15:05
43	155.400004	0.746796	4.443382	12.389263	3/9/2016	17:16:05
44	151.521167	0.71926	4.336788	12.36086	3/9/2016	17:17:05
45	148.454869	0.73795	4.459522	12.296325	3/9/2016	17:18:04
46	136.981233	0.789645	4.428454	12.220377	3/9/2016	17:19:04
47	136.762901	0.755331	4.454178	12.216128	3/9/2016	17:20:04
48	129.659152	0.741316	4.400318	12.187813	3/9/2016	17:21:04
49	137.077873	0.787868	4.408579	12.195099	3/9/2016	17:22:04
50	130.961193	0.670244	4.373363	12.102958	3/9/2016	17:23:04
51	133.283704	0.757732	4.358215	12.109538	3/9/2016	17:24:04
52	136.9779	0.692274	4.3655	12.136932	3/9/2016	17:25:04
53	136.54322	0.805501	4.32986	12.138664	3/9/2016	17:26:03
54	135.704381	0.743173	4.367173	12.148495	3/9/2016	17:27:03
55	135.418707	0.742926	4.363909	12.157769	3/9/2016	17:28:03
56	126.593709	0.688768	4.364465	12.089838	3/9/2016	17:29:03
57	123.02625	0.744822	4.402902	12.093497	3/9/2016	17:30:03
58	127.60354	0.724021	4.336001	12.079033	3/9/2016	17:31:03
59	133.816684	0.715738	4.439095	12.127929	3/9/2016	17:32:03
60	126.843992	0.669502	4.35984	12.102169	3/9/2016	17:33:03
AVG	139.21	0.74	4.38	12.15		
ppm@15% O2	67.88	0.36				

Calculated Emission Levels

NOx (g/bhp-hr)	NOx (lbs/hr)	CO (g/bhp-hr)	CO (lbs/hr)	HCOH Dry (ppm)	HCOH@15% O2 (ppm)	HCOH (g/bhp-hr)	HCOH (lbs/hr)
1.06	2.77	0.00	0.01	4.98	2.43	0.025	0.065

APPENDIX B

Raw Calibration Data

BACKGROUND

Date	Time	NO 191C span	NO2 191C span	H2O% (high) 191C	Formaldehyde 191C	Ethylene 191C TE span	Propane 191C span	Acetaldehyde 191C span	CO ppm 191C (1of2) span	CO ppm Dry	CO2% 191C	NOx Wet	NOx Dry	NM NE HC C3
3/9/2016	12:50:56	-0.108401	0.027287	0.006146	-0.202242	1.451384	0.36204	0.845479	-0.066611	-0.066615	-0.014574	-0.079133	-0.079138	0.069912
3/9/2016	12:51:03	-0.275923	0.047298	0.001181	-0.033442	1.792285	0.4449	1.850432	-0.219505	-0.219507	-0.014331	-0.228625	-0.228627	0.322875
3/9/2016	12:51:10	-0.080491	-0.00602	0.013685	-0.051999	2.363154	0.043248	1.780434	-0.082547	-0.082558	-0.0123	-0.068612	-0.068621	1.318007
3/9/2016	12:51:47	0	0	0	0	0	0	0	0	0	0	0	0	0
3/9/2016	12:52:00	0.457988	0.040078	-0.05771	-0.077318	-0.024905	0.809337	0.178788	0.095831	0.095825	0.000139	0.498064	0.498038	0.225199
3/9/2016	12:52:06	0.050197	-0.020861	-0.050907	0.019144	0.029382	-0.44227	0.269718	0.021638	0.021834	-0.003828	0.029965	0.029965	1.822020
3/9/2016	12:52:15	0.028625	-0.139351	-0.063774	0.029991	1.215286	-0.020402	-0.14446	0.019363	0.019363	-0.00938	-0.112957	-0.111119	0.071764
3/9/2016	12:52:22	0.112327	-0.064915	-0.00136	-0.174051	0.755089	1.232319	-0.482199	-0.202832	-0.202836	0.009619	0.047412	0.047413	0.955918
3/9/2016	12:52:30	0.124106	-0.0870777	-0.00112	-0.087417	0.406875	-0.583321	-0.17936	0.078122	0.078121	0.009623	0.027028	0.027028	0.000378
3/9/2016	12:52:37	0.092868	-0.016817	-0.000456	-0.140055	0.040621	0.312312	-0.270513	-0.061441	-0.061441	0.013028	0.075851	0.075851	0.024543
3/9/2016	12:52:45	-0.127321	0.062381	0.001437	-0.078125	1.338156	-0.479892	0.48971	0.066976	0.066977	0.000971	-0.064986	-0.064986	0.046917
3/9/2016	12:52:52	-0.048857	-0.001622	0.000086	0.1033	0.744983	0.049853	-0.199486	0.185646	0.185646	-0.014027	-0.050279	-0.050279	0.001419
3/9/2016	12:53:00	-0.050149	-0.0033032	0.002702	-0.111413	0.494519	0.078577	0.267368	-0.09949	-0.099492	-0.004692	-0.053181	-0.053183	0.000987

PRE DIRECT CAL

Date	Time	CO ppm 191C (1of2) span	NOx Wet	Propane 191C span	Date	Time	Ethylene 191C TE	Date	Time	Acetaldehyde 191C span
3/9/2016	12:53:07	68.557425	76.940426	68.00659	3/9/2016	13:01:51	95.911758	3/9/2016	12:58:48	26.241532
3/9/2016	12:53:15	368.532221	368.300072	369.917002	3/9/2016	13:01:59	100.474473	3/9/2016	12:58:56	31.376725
3/9/2016	12:53:22	468.365337	468.853213	464.21625	3/9/2016	13:02:06	101.420458	3/9/2016	12:59:03	31.226026
3/9/2016	12:53:30	494.311581	491.578304	487.413138	3/9/2016	13:02:14	101.339933	3/9/2016	12:59:11	31.216868
3/9/2016	12:53:37	496.468722	494.736284	498.746559	3/9/2016	13:02:21	101.170723	3/9/2016	12:59:18	31.429075
3/9/2016	12:53:45	498.136754	494.359775	499.717679	3/9/2016	13:02:29	101.526445	3/9/2016	12:59:26	31.782899
3/9/2016	12:53:52	496.578418	494.78133	493.811387	3/9/2016	13:02:36	101.697917	3/9/2016	12:59:33	30.541984
3/9/2016	12:54:00	497.115497	495.24917	494.44189	3/9/2016	13:02:44	101.816128	3/9/2016	12:59:41	31.626075
3/9/2016	12:54:07	497.889758	495.364163	495.165869	3/9/2016	13:02:51	101.748612	3/9/2016	12:59:49	101.146996
3/9/2016	12:54:15	496.110221	495.589861	496.02702	3/9/2016	13:02:59				
3/9/2016	12:54:22	496.818783	495.557859	497.73462						

NO2 CAL

Date	Time	NO2 191C span
3/9/2016	13:00:22	104.398259
3/9/2016	13:00:29	136.139334
3/9/2016	13:00:37	139.269862
3/9/2016	13:00:44	140.427396
3/9/2016	13:00:52	141.120849
3/9/2016	13:00:59	142.183541
3/9/2016	13:01:07	142.551788
3/9/2016	13:01:14	142.822482
3/9/2016	13:01:22	143.057021
3/9/2016	13:01:29	143.886677

PRE SYSTEM CAL

Date	Time	CO ppm 191C (1of2) span	NOx Wet	Propane 191C span	Date	Time	Ethylene 191C TE	Date	Time	Acetaldehyde 191C span
3/9/2016	13:03:25	3.62277	76.277119	3.116887	3/9/2016	13:06:57	26.895466	3/9/2016	13:05:25	-0.048101
3/9/2016	13:03:32	97.821323	225.575846	92.757332	3/9/2016	13:07:05	97.344855	3/9/2016	13:05:35	21.569513
3/9/2016	13:03:39	425.804247	422.681303	426.178297	3/9/2016	13:07:12	100.201387	3/9/2016	13:05:42	29.728566
3/9/2016	13:03:47	444.975975	440.24587	443.248674	3/9/2016	13:07:20	102.052693	3/9/2016	13:05:50	30.287048
3/9/2016	13:03:54	453.93938	450.04372	453.027675	3/9/2016	13:07:27	101.910163	3/9/2016	13:05:57	30.466829
3/9/2016	13:03:59	460.580749	456.297655	461.867755	3/9/2016	13:07:35	103.628121	3/9/2016	13:06:05	30.741946
3/9/2016	13:04:06	466.121347	462.178451	468.879158	3/9/2016	13:07:42	101.755391	3/9/2016	13:06:12	30.221879
3/9/2016	13:04:17	472.222208	467.803388	470.472222	3/9/2016	13:07:50	102.625238	3/9/2016	13:06:20	31.270242
3/9/2016	13:04:24	474.082866	468.978451	471.736721	3/9/2016	13:07:57	101.675969	3/9/2016	13:06:27	30.883487
3/9/2016	13:04:32	475.05532	470.106877	473.62825	3/9/2016	13:08:05	101.761638	3/9/2016	13:06:35	31.238761
3/9/2016	13:04:39	477.416026	471.957923	478.350965						
3/9/2016	13:04:47	479.546111	473.499893	475.779404						
3/9/2016	13:04:54	481.425993	476.881652	475.198281						
3/9/2016	13:05:02	486.051972	480.772219	484.194177						

SAMPLE SPIKE RECOVERY

Date	Time	CO2% 191C	CO ppm 191C (1of2) span	NO 191C span	Propane 191C span
3/9/2016	13:14:34	6.51982	0.998749	193.42736	7.012912
3/9/2016	13:14:42	6.533325	0.798133	188.423688	6.132685
3/9/2016	13:14:48	6.499956	0.793501	184.224115	7.868583
3/9/2016	13:15:57	6.520909	1.117988	182.440461	7.95959
3/9/2016	13:15:04	6.511959	0.634924	191.859371	7.059245
3/9/2016	13:15:42	6.496317	0.779937	181.901394	6.160958
3/9/2016	13:15:49	6.538943	0.979924	177.117084	7.847254
3/9/2016	13:15:57	6.45361	1.037302	169.901703	7.428099
3/9/2016	13:18:05	1.453118	17.946176	80.340013	18.930317
3/9/2016	13:18:12	3.066515	390.997818	394.661656	384.653073
3/9/2016	13:18:19	5.208435	95.863076	252.258414	99.579901
3/9/2016	13:18:27	5.934866	52.06301	222.224803	57.422192
3/9/2016	13:18:34	5.952618	51.084581	215.607833	55.826965
3/9/2016	13:18:42	5.977415	50.384473	220.44226	55.203408
3/9/2016	13:18:49	5.97003	50.342419	213.732917	54.963645
3/9/2016	13:18:57	5.865346	54.88639	218.047781	60.054544
3/9/2016	13:17:18	5.864537	56.40377	223.211038	60.861514
3/9/2016	13:17:27	5.866399	55.44293	222.00179	61.053033
3/9/2016	13:17:34	5.860379	55.52082	221.768122	60.146775
3/9/2016	13:17:42	5.871532	55.711891	217.381286	60.797132
3/9/2016	13:17:49	5.85567	55.539997	211.514454	59.183714
3/9/2016	13:17:57	5.889302	55.598783	215.526464	59.98458
3/9/2016	13:18:04	5.867433	55.135013	222.731829	60.303542
3/9/2016	13:18:12	5.847043	55.825022	220.21405	60.420707
3/9/2016	13:18:19	5.173902	55.465143	198.179542	60.888211

ACETALDEHYDE SPIKE RECOVERY

Date	Time	CO2% 191C	Acetaldehyde 191C span
3/9/2016	13:08:30	2.39725	0.24584
3/9/2016	13:08:37	2.424843	-0.47292
3/9/2016	13:08:45	2.414553	-1.059542
3/9/2016	13:08:52	2.410187	0.075784
3/9/2016	13:09:00	2.101355	-0.413141
3/9/2016	13:09:07	0.17554	0.750403
3/9/2016	13:09:15	0.015277	0.568903
3/9/2016	13:09:22	0.009463	0.105605
3/9/2016	13:09:30	0.010688	0.134413
3/9/2016	13:09:37	0.014297	0.455821
3/9/2016	13:09:45	0.01525	-0.853812
3/9/2016	13:09:52	0.45114	-0.711223
3/9/2016	13:10:00	6.872320	-0.754024
3/9/2016	13:10:07	6.79218	-0.896792
3/9/2016	13:10:37	6.637808	-0.725114
3/9/2016	13:10:45	6.82571	-0.314205
3/9/2016	13:10:52	6.646387	-0.941751
3/9/2016	13:11:00	2.552873	4.878682
3/9/2016	13:11:07	2.290081	17.713673
3/9/2016	13:11:15	5.898681	3.235722
3/9/2016	13:11:22	5.929898	2.95148
3/9/2016	13:11:30	5.934616	3.211028
3/9/2016	13:11:37	5.924279	3.279718
3/9/2016	13:11:45	5.91164	3.244919
3/9/2016	13:11:52	5.969662	2.402093
3/9/2016	13:12:00	6.046744	2.078547
3/9/2016	13:12:07	6.027982	1.921403
3/9/2016	13:12:15	6.002802	1.391404
3/9/2016	13:12:22	6.014418	1.229589
3/9/2016	13:12:29	6.082884	1.963084
3/9/2016	13:12:37	6.142037	2.261556
3/9/2016	13:12:59	6.168852	1.762099
3/9/2016	13:13:07	6.161739	1.351186
3/9/2016	13:13:15	6.192714	1.236308
3/9/2016	13:13:22	6.103026	1.22192
3/9/2016	13:13:29	6.092575	1.803908
3/9/2016	13:13:37	6.180173	0.797997
3/9/2016	13:13:44	6.16966	1.180538
3/9/2016	13:13:52	6.140693	1.699532
3/9/2016	13:13:59	6.169451	1.744125
3/9/2016	13:14:07	6.175178	1.056339

POST DIRECT CAL

Date	Time	CO ppm 191C (1of2) span	NOx Wet	Propane 191C span	Date	Time	Ethylene 191C TE	Date	Time	Acetaldehyde 191C span
3/9/2016	17:38:28	428.683336	431.413379	422.487247	3/9/2016	17:36:58	7.231024	3/9/2016	17:39:59	16.441204
3/9/2016	17:38:35	478.886929	471.734436	470.72485	3/9/2016	17:37:06	6.43889	3/9/2016	17:40:06	31.385884
3/9/2016	17:38:43	499.165817	491.891503	491.712785	3/9/2016	17:37:13	5.543975	3/9/2016	17:40:13	32.17277
3/9/2016	17:38:50	503.262171	498.410991	502.360703	3/9/2016	17:37:21	53.124009	3/9/2016	17:40:21	31.824602
3/9/2016	17:38:58	502.847862	500.145164	495.785904	3/9/2016	17:37:28	102.068644	3/9/2016	17:40:28	31.907779
3/9/2016	17:39:05	503.858135	500.55353	499.902793	3/9/2016	17:37:36	102.631123	3/9/2016	17:40:36	32.139109
3/9/2016	17:39:13	502.083311	500.292986	488.781061	3/9/2016	17:37:43	103.347208	3/9/2016	17:40:43	31.690289
3/9/2016	17:39:20	503.262254	500.024691	500.653841	3/9/2016	17:37:51	102.209693	3/9/2016	17:40:51	31.380549
3/9/2016	17:39:28	501.71223	499.503024	467.107581	3/9/2016	17:37:58	102.544732	3/9/2016	17:40:58	30.764487
3/9/2016	17:39:35	503.81288	500.564454	487.632986	3/9/2016	17:38:06	102.201068			

FTIR QA/QC SUMMARY

SAMPLE RECOVERY CALCULATIONS																
Period	Spike #	Concentration of CO Cylinder	Concentration of Propane Cylinder	Concentration of NO Cylinder	Stack CO ₂ Concentration	Stack CO Concentration	Stack NO Concentration	Stack Propane Concentration	Stack + Spike CO ₂ Concentration	Stack + CO Concentration	Stack + NO Concentration	Stack + Propane Concentration	DF Calculated	% Recovery CO	% Recovery NO	% Recovery Propane
PRE TEST	1	504.0	498.0	500.3	6.5	0.9	183.4	7.1	5.9	53.1	219.7	58.2	0.091	113.8%	116.2%	113.8%

ACETALDEHYDE SAMPLE RECOVERY CALCULATIONS								
Period	Spike #	Concentration of CH ₃ CHO Cylinder	Stack CO ₂ Concentration	Stack CH ₃ CHO Concentration	Stack + Spike CO ₂ Concentration	Stack + CH ₃ CHO Concentration	DF Calculated	% Recovery CH ₃ CHO
PRE TEST	1	30.2	6.7	-0.7	6.2	1.3	0.084	78.1%

PRE SYSTEM CAL			
Sensor	System Response (ppm)	Cal Level (ppm)	Cal Recovery (%)
NOx	480.8	500.3	-3.90
CO	485.1	504.0	-3.76
Propane	484.2	498.0	-2.78
Ethylene*	101.8	102.4	-0.62
Acetaldehyde	31.2	30.2	3.36

PRE DIRECT CAL					
Sensor	Analyzer Response (ppm)	Cal Level (ppm)	Zero Response (ppm)	Cal Error (%)	Zero Error (%)
NOx	495.6	500.3	0.4	-0.95	0.08
CO	496.8	504.0	-0.1	-1.42	-0.01
Propane	497.7	498.0	0.4	-0.05	0.08
Ethylene	101.1	102.4	-0.4	-1.22	-0.40
Acetaldehyde	31.6	30.2	-0.4	4.65	-1.36

POST DIRECT CAL					
Sensor	Analyzer Response (ppm)	Cal Level (ppm)	Zero Response (ppm)	Cal Error (%)	Zero Error (%)
NOx	500.6	500.3	0.3	0.05	0.06
CO	503.5	504.0	0.1	-0.10	0.02
Propane	497.6	498.0	0.4	-0.07	0.08
Ethylene	102.2	102.4	-0.4	-0.19	-0.40
Acetaldehyde	30.8	30.2	0.4	1.77	1.35

*CTS Scans are conducted with Ethylene through the sample line

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number: E05NI99E15A0000
 Cylinder Number: SG9163466BAL
 Laboratory: ASG - Chicago - IL
 PGVP Number: B12015
 Gas Code: CH4,CO,NO,NOX,PPN,BALN

Reference Number: 54-124493548-1
 Cylinder Volume: 144.4 CF
 Cylinder Pressure: 2015 PSIG
 Valve Outlet: 660
 Certification Date: May 20, 2015

Expiration Date: May 20, 2023

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	500.0 PPM	500.3 PPM	G1	+/- 0.6% NIST Traceable	05/13/2015, 05/20/2015
CARBON MONOXIDE	500.0 PPM	504.0 PPM	G1	+/- 1.0% NIST Traceable	05/13/2015
METHANE	500.0 PPM	499.9 PPM	G1	+/- 1.0% NIST Traceable	05/14/2015
NITRIC OXIDE	500.0 PPM	500.3 PPM	G1	+/- 0.6% NIST Traceable	05/13/2015, 05/20/2015
PROPANE	500.0 PPM	498.0 PPM	G1	+/- 1% NIST Traceable	05/15/2015
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	12062431	CC366888	487.1 PPM CARBON MONOXIDE/NITROGEN	+/- 0.6%	Jun 22, 2018
PRM	12312	680179	10.01 PPM NITROGEN DIOXIDE/NITROGEN	+/- 2.0%	Feb 14, 2012
NTRM	10060909	CC320616	500.5 PPM METHANE/NITROGEN	+/- 0.6%	Aug 07, 2016
NTRM	12061027	CC359428	500.7 PPM NITRIC OXIDE/NITROGEN	+/- 0.5%	Feb 16, 2018
GMIS	0207201402	CC500987	4.845 PPM NITROGEN DIOXIDE/NITROGEN	+/- 2.0%	Feb 07, 2017
NTRM	10060514	CC281296	495.3 PPM PROPANE/AIR	+/- 0.5%	Feb 19, 2016

The SRM, PRM or RGM noted above is only in reference to the GMIS used in the assay and not part of the analysis.

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nexus 470 AEP0000428	FTIR	Apr 16, 2015
Nicolet 6700 AHR0801332	FTIR	May 08, 2015
Nexus 470 AEP0000428	FTIR	May 16, 2015
Nexus 470 AEP0000428	FTIR	May 16, 2015
MKS Multigas 17707558	FTIR	May 08, 2015

Triad Data Available Upon Request



CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Airgas Specialty Gases
12722 South Wentworth Avenue
Chicago, IL 60628
(773) 785-3000 Fax: (773) 785-1928
Airgas.com

Part Number: E03NI99E15A2059
Cylinder Number: CC500474
Laboratory: ASG - Chicago - IL
PGVP Number: B12015
Gas Code: NO2,O2,BALN

Reference Number: 54-124488819-1
Cylinder Volume: 144.4 Cubic Feet
Cylinder Pressure: 2015 PSIG
Valve Outlet: 660
Certification Date: Apr 24, 2015

Expiration Date: Apr 24, 2018

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NITROGEN DIOXIDE	150.0 PPM	144.5 PPM	G1	+/- 2%	04/17/2015, 04/24/2015
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
GMIS	124415809101	CC501027	196.8 PPM NITROGEN DIOXIDE/NITROGEN	+/- 1.1%	Aug 20, 2017
PRM	12326	APEX1005712	250.4 PPM NITROGEN DIOXIDE/NITROGEN	+/- 1.0%	Jul 15, 2015

The SRM, PRM or RGM noted above is only in reference to the GMIS used in the assay and not part of the analysis.

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
MKS Multigas 17707558	FTIR	Apr 08, 2015

Triad Data Available Upon Request



CERTIFICATE OF ANALYSIS**Grade of Product: PRIMARY STANDARD**

Part Number:	X02NI99P15AD524	Reference Number:	54-124520303-2
Cylinder Number:	CC192905	Cylinder Volume:	144.4 CF
Laboratory:	ASG - Chicago - IL	Cylinder Pressure:	2015 PSIG
Analysis Date:	Oct 28, 2015	Valve Outlet:	350
Lot Number:	54-124520303-2		

Primary Standard Gas Mixtures are traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
ETHYLENE	100.0 PPM	102.4 PPM	+/- 1%
NITROGEN	Balance		



CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED HYDROCARBON

Customer: *HENDERSON,, CO* - OASIS EMISSION
Part Number: X02NI99C80AC031
Cylinder Number: LL106285
Laboratory: ASG - LaPorte Mix (SAP) - TX
Analysis Date: Aug 14, 2015
Lot Number: 126-400584491-1

Reference Number: 126-400584491-1
Cylinder Volume: 75.2 CF
Cylinder Pressure: 2000 PSIG
Valve Outlet: 350SS
Expiration Date: Aug 14, 2016

Traceability Statement: Hydrocarbon Process standards are NIST traceable either directly by weight or by comparison to Airgas laboratory standards that are directly NIST traceable by weight.

CERTIFIED CONCENTRATIONS

Component	Requested Concentration	Reported Mole %	Accuracy
ACETALDEHYDE	30.00 PPM	30.22 PPM	+/- 5%
NITROGEN	Balance	Balance	

Notes:
PO # CODY

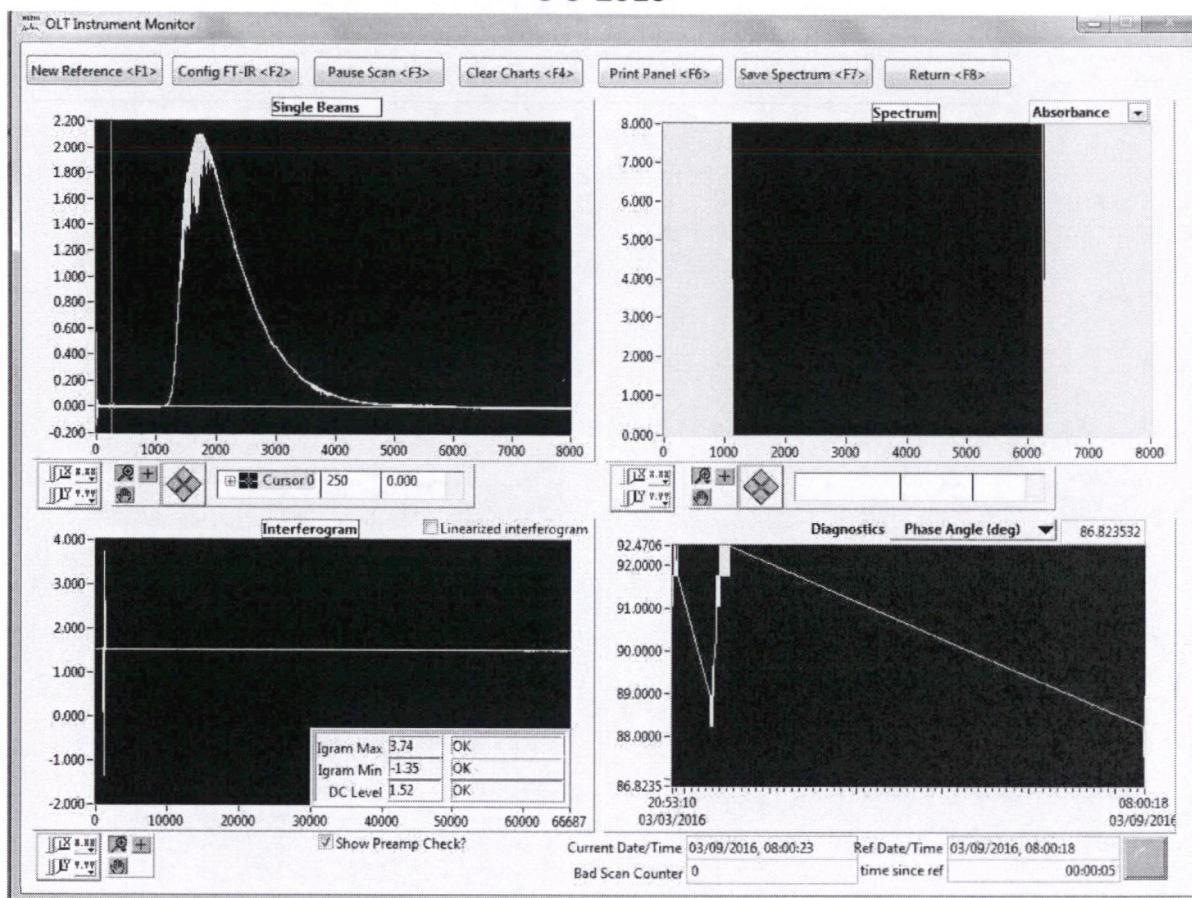


Signature on file

Approved for Release

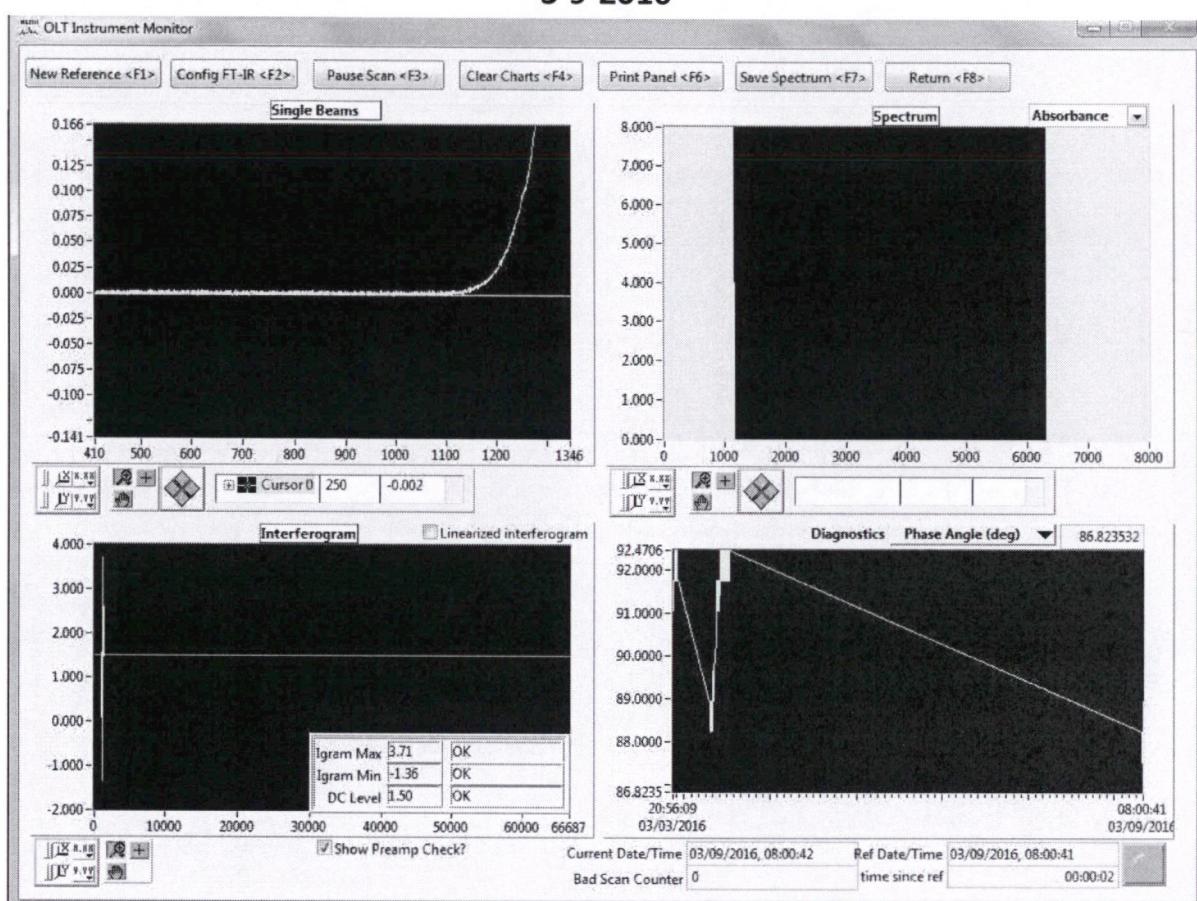
XTO – LCU #4

3-9-2016



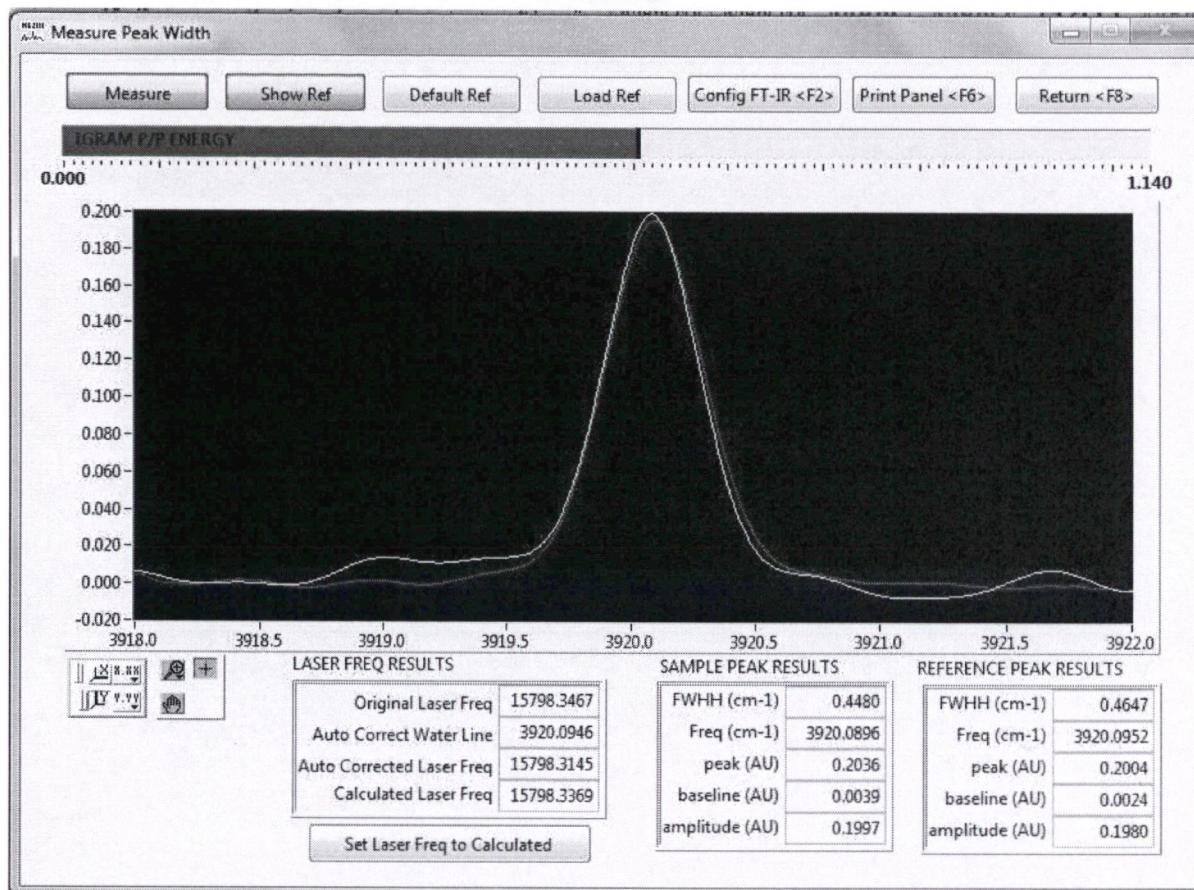
XTO – LCU #4

3-9-2016



XTO – LCU #4

3-9-2016



Instrument Resolution – FWHH – 0.4480 cm⁻¹ which is < 0.55 cm⁻¹ (therefore meets ASTM)
Water Frequency – Freq – 3920.0896 cm⁻¹ which is +/- 0.075 of 3920.0952 cm⁻¹ (therefore meets ASTM)

Please note: FWHH is the Full Width at Half Height of the resolution. The frequency position is only calculating the center line for one water line in the spectrum. MKS uses 3920.0952 cm⁻¹ since it is a single water line.

APPENDIX C

G3516
GAS ENGINE SITE SPECIFIC TECHNICAL DATA
XTO - LCU #4
CATERPILLAR®

GAS COMPRESSION APPLICATION

ENGINE SPEED (rpm):	1352	RATING STRATEGY:	STANDARD
COMPRESSION RATIO:	8	RATING LEVEL:	CONTINUOUS
AFTERCoolER TYPE:	SCAC	FUEL SYSTEM:	HPG IMPCO
AFTERCoolER WATER INLET (°F):	130		WITH AIR FUEL RATIO CONTROL
JACKET WATER OUTLET (°F):	210		
ASPIRATION:	TA		
COOLING SYSTEM:	JW+OC, AC	FUEL:	Field Gas
CONTROL SYSTEM:	ADEM3	FUEL PRESSURE RANGE(psig):	35.0-40.0
EXHAUST MANIFOLD:	ASWC	FUEL METHANE NUMBER:	62.1
COMBUSTION:	LOW EMISSION	FUEL LHV (Btu/scf):	1027
NOx EMISSION LEVEL (g/bhp-hr NOx):	2.0	ALTITUDE(ft):	5278
SET POINT TIMING:	27	MAXIMUM INLET AIR TEMPERATURE(°F):	52
		STANDARD RATED POWER:	1340 bhp@1400rpm

RATING	NOTES	LOAD	MAXIMUM RATING	SITE RATING AT MAXIMUM INLET AIR TEMPERATURE		
	(WITHOUT FAN)	bhp °F	100%	100%	75%	53%
ENGINE POWER INLET AIR TEMPERATURE		(1)	1294 42	1262 52	947 52	670 52

ENGINE DATA						
FUEL CONSUMPTION (LHV)	(2)	Btu/bhp-hr	7698	7720	7961	8400
FUEL CONSUMPTION (HHV)	(2)	Btu/bhp-hr	8506	8531	8796	9281
AIR FLOW (@inlet air temp, 14.7 psia)	(WET)	ft³/min	2570	2557	1929	1399
AIR FLOW	(WET)	lb/hr	12185	11891	8969	6508
FUEL FLOW (60°F, 14.7 psia)		scfm	162	158	122	91
INLET MANIFOLD PRESSURE		in Hg(abs)	68.8	67.4	53.0	39.7
EXHAUST TEMPERATURE - ENGINE OUTLET		°F	907	907	906	909
EXHAUST GAS FLOW (@engine outlet temp, 14.5 psia)	(WET)	ft³/min	7566	7384	5576	4062
EXHAUST GAS MASS FLOW	(WET)	lb/hr	12665	12360	9332	6779

EMISSIONS DATA - ENGINE OUT						
NOx (as NO ₂)	(8)(9)	g/bhp-hr	2.00	2.00	2.00	2.00
CO	(8)(9)	g/bhp-hr	2.25	2.26	2.36	2.50
THC (mol. wt. of 15.84)	(8)(9)	g/bhp-hr	2.43	2.44	2.54	2.67
NMHC (mol. wt. of 15.84)	(8)(9)	g/bhp-hr	0.63	0.63	0.66	0.69
NMNEHC (VOCs) (mol. wt. of 15.84)	(8)(9)(10)	g/bhp-hr	0.42	0.42	0.44	0.47
HCHO (Formaldehyde)	(8)(9)	g/bhp-hr	0.22	0.22	0.22	0.23
CO ₂	(8)(9)	g/bhp-hr	507	508	517	539
EXHAUST OXYGEN	(8)(11)	% DRY	7.8	7.8	7.7	7.5

HEAT REJECTION						
HEAT REJ. TO JACKET WATER (JW)	(12)	Btu/min	42377	41795	34952	29271
HEAT REJ. TO ATMOSPHERE	(12)	Btu/min	5131	5047	4213	3482
HEAT REJ. TO LUBE OIL (OC)	(12)	Btu/min	6320	6233	5213	4365
HEAT REJ. TO AFTERCOOLER (AC)	(12)(13)	Btu/min	8677	8677	5161	1992

COOLING SYSTEM SIZING CRITERIA			
TOTAL JACKET WATER CIRCUIT (JW+OC)	(13)	Btu/min	54198
TOTAL AFTERCOOLER CIRCUIT (AC)	(13)(14)	Btu/min	9111

A cooling system safety factor of 0% has been added to the cooling system sizing criteria.

CONDITIONS AND DEFINITIONS

Engine rating obtained and presented in accordance with ISO 3046/1, adjusted for fuel, site altitude and site inlet air temperature. 100% rating at maximum inlet air temperature is the maximum engine capability for the specified fuel at site altitude and maximum site inlet air temperature. Maximum rating is the maximum capability at the specified aftercooler inlet temperature for the specified fuel at site altitude and reduced inlet air temperature. Lowest load point is the lowest continuous duty operating load allowed. No overload permitted at rating shown.

For notes information consult page three.

Run 1 - intake man press -> 30.2 psi -> 61.49 in Hg

Pabs = 61.49 in Hg

by linear interpolation, est BHP => 1132.7 BHP

G3516

GAS COMPRESSION APPLICATION

GAS ENGINE SITE SPECIFIC TECHNICAL DATA XTO - LCU #4

CATERPILLAR®

ENGINE SPEED (rpm):	1369
COMPRESSION RATIO:	8
AFTERCoolER TYPE:	SCAC
AFTERCoolER WATER INLET (°F):	130
JACKET WATER OUTLET (°F):	210
ASPIRATION:	TA
COOLING SYSTEM:	JW+OC, AC
CONTROL SYSTEM:	ADEM3
EXHAUST MANIFOLD:	ASWC
COMBUSTION:	LOW EMISSION
NOx EMISSION LEVEL (g/bhp-hr NOx):	2.0
SET POINT TIMING:	27

RATING STRATEGY:	STANDARD
RATING LEVEL:	CONTINUOUS
FUEL SYSTEM:	HPG IMPCO
	WITH AIR FUEL RATIO CONTROL
	Field Gas
	35.0-40.0
	62.1
	1027
	5278
	53
MAXIMUM RATED POWER:	1340 bhp@1400rpm

RATING	NOTES	LOAD	100%	100%	75%	53%
ENGINE POWER INLET AIR TEMPERATURE (WITHOUT FAN)	(1)	bhp °F	1310 42	1270 53	952 53	670 53

ENGINE DATA							
FUEL CONSUMPTION (LHV)		(2)	Btu/bhp-hr	7707	7735	7983	8441
FUEL CONSUMPTION (HHV)		(2)	Btu/bhp-hr	8516	8546	8821	9327
AIR FLOW (@inlet air temp, 14.7 psia)	(WET)	(3)(4)	ft³/min	2605	2584	1951	1410
AIR FLOW	(WET)	(3)(4)	lb/hr	12367	11995	9054	6543
FUEL FLOW (60°F, 14.7 psia)			scfm	164	159	123	92
INLET MANIFOLD PRESSURE		(5)	in Hg(abs)	69.2	67.4	53.1	39.6
EXHAUST TEMPERATURE - ENGINE OUTLET		(6)	°F	907	907	907	910
EXHAUST GAS FLOW (@engine outlet temp, 14.5 psia)	(WET)	(7)(4)	ft³/min	7680	7450	5630	4086
EXHAUST GAS MASS FLOW	(WET)	(7)(4)	lb/hr	12853	12468	9421	6815

EMISSIONS DATA - ENGINE OUT							
NOx (as NO2)		(8)(9)	g/bhp-hr	2.00	2.00	2.00	2.00
CO		(8)(9)	g/bhp-hr	2.27	2.29	2.39	2.54
THC (mol. wt. of 15.84)		(8)(9)	g/bhp-hr	2.43	2.44	2.55	2.69
NMHC (mol. wt. of 15.84)		(8)(9)	g/bhp-hr	0.63	0.63	0.66	0.70
NMNEHC (VOCs) (mol. wt. of 15.84)		(8)(9)(10)	g/bhp-hr	0.42	0.43	0.44	0.47
HCHO (Formaldehyde)		(8)(9)	g/bhp-hr	0.22	0.22	0.22	0.24
CO2		(8)(9)	g/bhp-hr	508	509	519	542
EXHAUST OXYGEN		(8)(11)	% DRY	7.8	7.8	7.7	7.5

HEAT REJECTION							
HEAT REJ. TO JACKET WATER (JW)		(12)	Btu/min	42822	42084	35269	29485
HEAT REJ. TO ATMOSPHERE		(12)	Btu/min	5195	5090	4251	3504
HEAT REJ. TO LUBE OIL (OC)		(12)	Btu/min	6386	6276	5260	4397
HEAT REJ. TO AFTERCOOLER (AC)		(12)(13)	Btu/min	8952	8952	5285	2032

COOLING SYSTEM SIZING CRITERIA							
TOTAL JACKET WATER CIRCUIT (JW+OC)		(13)	Btu/min	54768			
TOTAL AFTERCOOLER CIRCUIT (AC)		(13)(14)	Btu/min	9400			

A cooling system safety factor of 0% has been added to the cooling system sizing criteria.

CONDITIONS AND DEFINITIONS

Engine rating obtained and presented in accordance with ISO 3046/1, adjusted for fuel, site altitude and site inlet air temperature. 100% rating at maximum inlet air temperature is the maximum engine capability for the specified fuel at site altitude and maximum site inlet air temperature. Maximum rating is the maximum capability at the specified aftercooler inlet temperature for the specified fuel at site altitude and reduced inlet air temperature. Lowest load point is the lowest continuous duty operating load allowed. No overload permitted at rating shown.

For notes information consult page three.

Run 2 - intake man press -> 30.5 psi -> 62.10 in Hg
Pabs = 62.10 in Hg

by linear interpolation, est BHP => 1152.1 BHP

G3516

GAS ENGINE SITE SPECIFIC TECHNICAL DATA XTO - LCU #4

CATERPILLAR®

GAS COMPRESSION APPLICATION

ENGINE SPEED (rpm):	1349
COMPRESSION RATIO:	8
AFTERCoolER TYPE:	SCAC
AFTERCoolER WATER INLET (°F):	130
JACKET WATER OUTLET (°F):	210
ASPIRATION:	TA
COOLING SYSTEM:	JW+OC, AC
CONTROL SYSTEM:	ADEM3
EXHAUST MANIFOLD:	ASWC
COMBUSTION:	LOW EMISSION
NOx EMISSION LEVEL (g/bhp-hr NOx):	2.0
SET POINT TIMING:	27

RATING STRATEGY:	STANDARD
RATING LEVEL:	CONTINUOUS
FUEL SYSTEM:	HPG IMPCO
	WITH AIR FUEL RATIO CONTROL
SITE CONDITIONS:	
FUEL:	Field Gas
FUEL PRESSURE RANGE(psig):	35.0-40.0
FUEL METHANE NUMBER:	62.1
FUEL LHV (Btu/scf):	1027
ALTITUDE(ft):	5278
MAXIMUM INLET AIR TEMPERATURE(°F):	52
STANDARD RATED POWER:	1340 bhp@1400rpm

RATING	(WITHOUT FAN)	NOTES	LOAD	MAXIMUM RATING			SITE RATING AT MAXIMUM INLET AIR TEMPERATURE		
				100%	100%	75%	53%		
ENGINE POWER INLET AIR TEMPERATURE		(1)	bhp °F	1291 42	1260 52	945 52	670 52		

ENGINE DATA	
FUEL CONSUMPTION (LHV)	(2)
FUEL CONSUMPTION (HHV)	(2)
AIR FLOW (@inlet air temp, 14.7 psia)	(WET)
AIR FLOW	(WET)
FUEL FLOW (60°F, 14.7 psia)	(3)(4)
INLET MANIFOLD PRESSURE	(3)(4)
EXHAUST TEMPERATURE - ENGINE OUTLET	(5)
EXHAUST GAS FLOW (@engine outlet temp, 14.5 psia)	(WET)
EXHAUST GAS MASS FLOW	(WET)
	(7)(4)
	(7)(4)

EMISSIONS DATA - ENGINE OUT	
NOx (as NO2)	(8)(9)
CO	(8)(9)
THC (mol. wt. of 15.84)	(8)(9)
NMHC (mol. wt. of 15.84)	(8)(9)
NMNEHC (VOCs) (mol. wt. of 15.84)	(8)(9)(10)
HCHO (Formaldehyde)	(8)(9)
CO2	(8)(9)
EXHAUST OXYGEN	(8)(11)
	g/bhp-hr
	% DRY

HEAT REJECTION	
HEAT REJ. TO JACKET WATER (JW)	(12)
HEAT REJ. TO ATMOSPHERE	(12)
HEAT REJ. TO LUBE OIL (OC)	(12)
HEAT REJ. TO AFTERCOOLER (AC)	(12)(13)
	Btu/min
	Btu/min
	Btu/min
	Btu/min

COOLING SYSTEM SIZING CRITERIA	
TOTAL JACKET WATER CIRCUIT (JW+OC)	(13)
TOTAL AFTERCOOLER CIRCUIT (AC)	(13)(14)
	Btu/min
	Btu/min

A cooling system safety factor of 0% has been added to the cooling system sizing criteria.

CONDITIONS AND DEFINITIONS

Engine rating obtained and presented in accordance with ISO 3046/1, adjusted for fuel, site altitude and site inlet air temperature. 100% rating at maximum inlet air temperature is the maximum engine capability for the specified fuel at site altitude and maximum site inlet air temperature. Maximum rating is the maximum capability at the specified aftercooler inlet temperature for the specified fuel at site altitude and reduced inlet air temperature. Lowest load point is the lowest continuous duty operating load allowed. No overload permitted at rating shown.

For notes information consult page three.

Run 3 - intake man press -> 31.3 psi -> 63.73 in Hg
Pabs = 63.73 in Hg

by linear interpolation, est BHP => 1181.4 BHP

APPENDIX D

EPA Method 19 Calculations

Test Run	Fd Factor	BSFC	Approx. BHP	Avg O2 %	NOx ppmvd	NOx g/bhp-hr	NOx lbs/hr	CO ppmvd	CO g/bhp-hr	CO lbs/hr	HCOH ppmvd	HCOH g/bhp-hr	HCOH lbs/hr	Moisture Content %
1	8710	9400	1132.7	8.6	260.00	1.95	4.88	0.92	0.00	0.01	5.01	0.025	0.062	12.23
2	8710	9400	1152.1	8.7	258.31	1.96	4.97	0.89	0.00	0.01	5.08	0.025	0.064	12.24
3	8710	9400	1181.4	8.8	139.21	1.06	2.77	0.74	0.00	0.01	4.98	0.025	0.065	12.15
Average Levels			1155.4	8.7	219.18	1.66	4.20	0.85	0.00	0.01	5.02	0.025	0.063	12.20

APPENDIX E

FTIR Engine Test Sheet

Company Name	XTO
Location / Unit I.D.	Little Canyon C5 LCU#4
Type of Test Completed:	FTIR 3x1w N.C.H
Field Technician (s)	Kevin Watkins
Client Rep and/or State Rep	Derrick (XTO)
Date:	3-9-16

	Test 1	Test 2	Test 3
Time of Readings	1:24 pm	2:29 pm	4:34 pm
Atm Pressure (in Hg)	24.62	24.62	24.63
Atm Temp (°F)	52°	53°	52°
Engine RPM	1352	1369	1349
"Manifold Pres. Vac(") or Boost(psi)	36.2	30.5	31.3
Manifold Temp (°F)	132°	132°	134°
Psuction (psi) Stage 1	31	32	30
Tsuction (°F) Stage 1	Raytech	56°	57°
Pdischarge (psi) Stage 1	133	135	129
Psuction (psi) Stage 2	133	135	129
Tsuction (°F) Stage 2			
Pdischarge (psi) Stage 2	426	434	420
Psuction (psi) Stage 3			
Tsuction (°F) Stage 3			
Pdischarge (psi) Stage 3			
Psuction (psi) Stage 4			
Tsuction (°F) Stage 4			
Pdischarge (psi) Stage 4			
Gas Throughput (mmcf/d)	6.7	6.7	6.7
Pre CO (ppm)			
Pre Cat Temp (°F)	820°	815°	813°
Post Cat Temp (°F)			
Cat Differential Pres. (" of H2O)	2.4"	2.4"	2.4"
Impinger 1 (grams)	/	/	/
Impinger 2 (grams)	/	/	/
Impinger 3 (grams)	/	/	/
Impinger 4 (grams)	/	/	/
Dry Gas Meter (cubic ft)	/	/	/
DGM Inlet Temp (deg F)	/	/	/
DGM Outlet Temp (deg F)	/	/	/
O2 %	8.6%	8.7%	8.8%
CO2 %	7.3%	7.3%	7.2%
LOAD %	Dry	95%	95%
Calculated by Mechanic			
Delta H			
Ignition Timing (°F)	27.3°	27.3°	29.5°
AFR Setting mV (Left Bank)			
AFR Setting mV (Right Bank)			
Upstream Port Distance (pd)			
Downstream Port Distance (pd)			
Exhaust Diameter (inches)	12"	Cylinder Serial #↓	
Propane	498		
NO	500.3		
CO	504		
NO2	144.5		
Ethylene	102.4		
Methane	499.9		
Acetaldehyde			
Engine Make	CAT		
Engine Model	3516 LF		
Engine S/N	4EK03003		

* Some units show boost in inches of Hg. In this situation please indicate if it is positive (+) or negative (-). Eg: (+12") or (-5")

Rev 5

5/25/2011

Max Load As Per Mechanic

X10 Little Canyon CO LLUT-7
12" Stack
3-10-16

Worksheet: O2 Stratification

Port	Point	Insertion Depth (inches)	Reading (%)
A	1	0.5	8.6
A	2	0.8	8.6
A	3	1.42	8.6
A	4	2.12	8.7
A	5	3	8.6
A	6	4.27	8.7
A	7	7.73	8.6
A	8	9	8.6
A	9	9.88	8.6
A	10	10.58	8.6
A	11	11.2	8.6
A	12	11.5	8.6
Average			8.6

Notes: To demonstrate non-stratified flow and utilize one sampling location
O2 may not deviate by more than +/- 0.3%.